



中认信通

CHINA CERTIFICATION ICT CO., LTD (DONGGUAN)



TEST REPORT

Applicant: Shenzhen Sonoff Technologies Co.,Ltd.

Address: 3F & 6F, Bldg A, No. 663, Bulong Rd, Shenzhen, Guangdong, China

FCC ID: 2APN5ZBCURTAIN

Product Name: Zigbee Smart Curtain Motor

Standard(s): 47 CFR Part 15, Subpart C(15.247)

ANSI C63.10-2013

KDB 558074 D01 15.247 Meas Guidance v05r02

The above equipment has been tested and found compliant with the requirement of the relative standards by China Certification ICT Co., Ltd (Dongguan)

Report Number: CR221263546-00A

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Test Facility

The Test site used by China Certification ICT Co., Ltd (Dongguan) to collect test data is located on the No. 113, Pingkang Road, Dalang Town, Dongguan, Guangdong, China.

The lab has been recognized as the FCC accredited lab under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No. : 442868, the FCC Designation No. : CN1314.

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier: CN0123.

Declarations

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
1.0	CR221263546-00A	Original Report	2023/2/8

1. GENERAL INFORMATION

1.1 Product Description for Equipment under Test (EUT)

EUT Name:	Zigbee Smart Curtain Motor
EUT Model:	ZBCurtain
Trade Name:	SONOFF
Operation Frequency:	BLE:2402-2480 MHz Zigbee:2405-2480 MHz
Maximum Peak Output Power (Conducted):	BLE:6.17dBm Zigbee:4.12dBm
Modulation Type:	BLE:GFSK Zigbee: OQPSK
Rated Input Voltage:	DC3.7V from battery or DC5V from adapter or DC 5V form Solar panel
Serial Number:	1WKY-9
EUT Received Date:	2022/12/29
EUT Received Status:	Good

For BLE:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	20	2442
1	2404
...
...
...	...	38	2478
19	2440	39	2480
Per section 15.31(m), the below frequencies were performed the test as below:			
Test Channel		Frequency (MHz)	
Lowest		2402	
Middle		2440	
Highest		2480	

For Zigbee:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
11	2405	19	2445
12	2410	20	2450
13	2415	21	2455
14	2420	22	2460
15	2425	23	2465
16	2430	24	2470
17	2435	25	2475
18	2440	26	2480
Per section 15.31(m), the below frequencies were performed the test as below:			
Test Channel		Frequency (MHz)	
Lowest		2405	
Middle		2440	
Highest		2480	

Antenna Information Detail▲:

Antenna Type		input impedance (Ohm)	Frequency Range	Antenna Gain
BLE	PCB	50	2.4~2.5 GHz	-0.8 dBi
Zigbee	PCB	50	2.4~2.5 GHz	-1.04 dBi

The Method of §15.203 Compliance:

- ☒ Antenna must be permanently attached to the unit.
☐ Antenna must use a unique type of connector to attach to the EUT.
☐ Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.

Accessory Information:

Accessory Description	Manufacturer	Model
/	/	/

1.2 Description of Test Configuration

1.2.1 EUT Operation Condition:

For BLE:

EUT Operation Mode:	The system was configured for testing in Engineering Mode, which was provided by the manufacturer.		
Equipment Modifications:	No		
EUT Exercise Software:	FCCTEST TOOL V2.3		
The software was provided by manufacturer. The maximum power was configured as below, that was provided by the manufacturer▲：			
Test Modes	Power Level Setting		
	Lowest Channel	Lowest Channel	Lowest Channel
BLE	Default	Default	Default

For Zigbee:

EUT Operation Mode:	The system was configured for testing in Engineering Mode, which was provided by the manufacturer.	
Equipment Modifications:	No	
EUT Exercise Software:	Device Control Panel	
The software was provided by manufacturer. The maximum power was configured as below, that was provided by the manufacturer▲：		
Test Channel	Frequency (MHz)	Power Level Setting
Lowest	2405	10.5
Middle	2440	10.5
Highest	2480	10.5

1.2.2 Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
DONG GUAN ORIENTAL.HERO ELECTRICAL FACTORY	AC ADAPTER	OH- 1015A0502000U4U-UL	E230965
SONOFF	Solar panel	Solar panel	1XRM

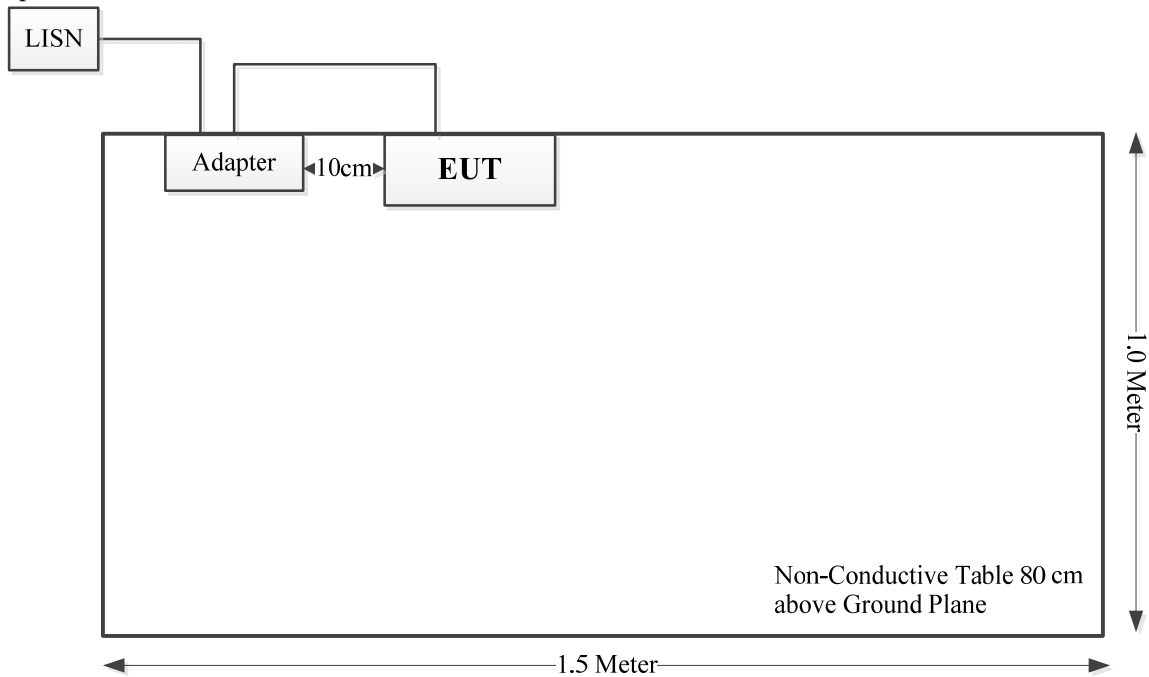
1.2.3 Support Cable List and Details

Cable Description	Shielding Type	Ferrite Core	Length (m)	From Port	To
USB Cable	No	No	2	EUT	Adapter

1.2.4 Block Diagram of Test Setup

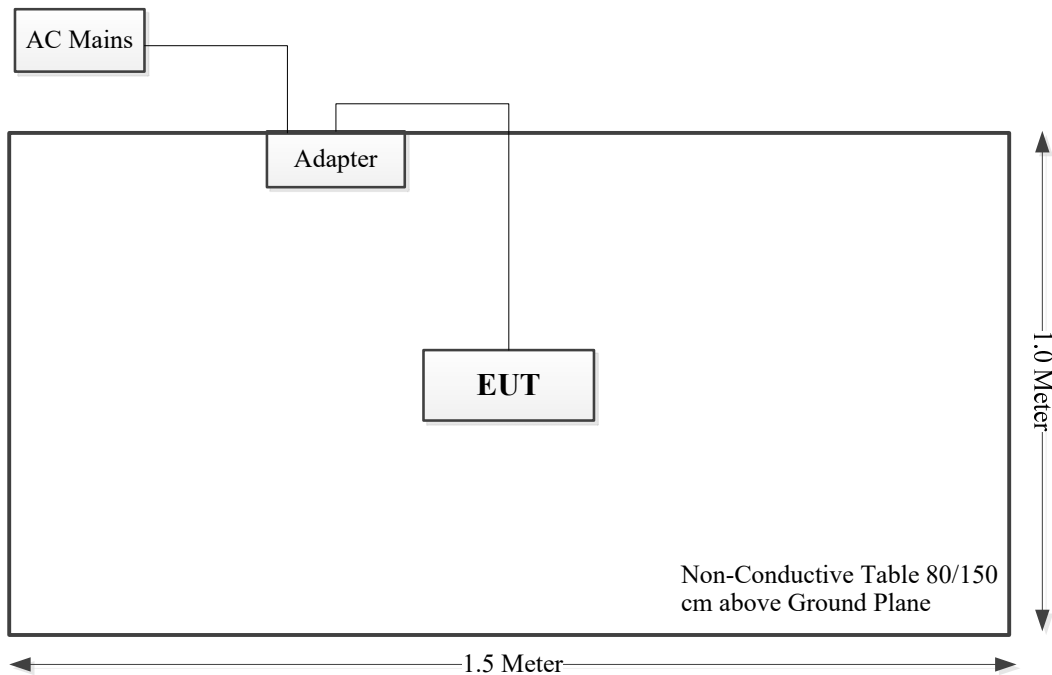
AC line conducted emissions:

Adapter:

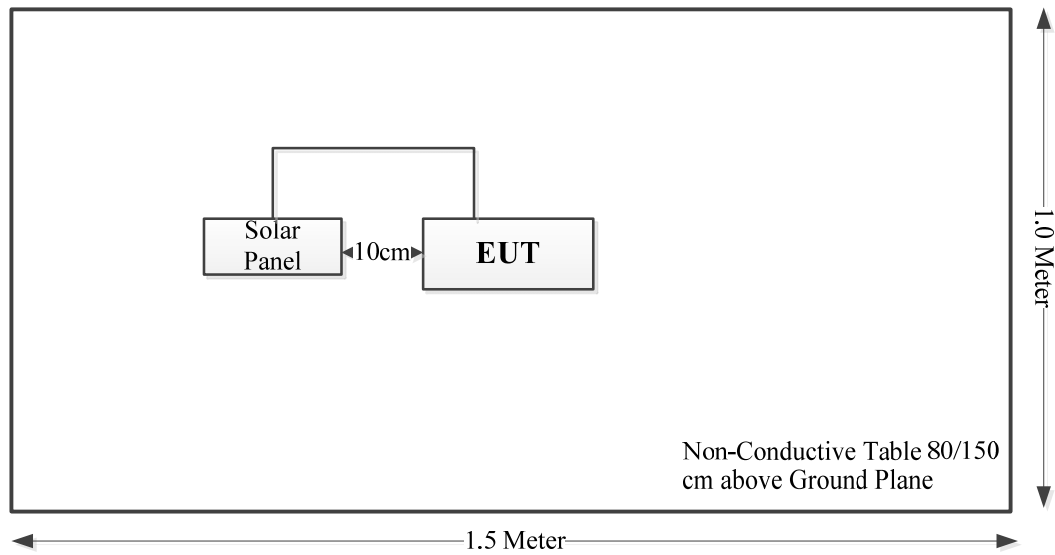


Spurious Emissions:

Adapter:



Solar panel:



1.3 Measurement Uncertainty

Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty. The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval.

Parameter	Measurement Uncertainty
Occupied Channel Bandwidth	±5 %
RF output power, conducted	±0.61dB
Power Spectral Density, conducted	±0.61 dB
Unwanted Emissions, radiated	30M~200MHz: 4.15 dB,200M~1GHz: 5.61 dB,1G~6GHz: 5.14 dB, 6G~18GHz: 5.93 dB,18G~26.5G:5.47 dB,26.5G~40G:5.63 dB
Unwanted Emissions, conducted	±1.26 dB
Temperature	±1℃
Humidity	±5%
DC and low frequency voltages	±0.4%
Duty Cycle	1%
AC Power Lines Conducted Emission	2.8 dB (150 kHz to 30 MHz)

2. SUMMARY OF TEST RESULTS

Standard(s) Section	Test Items	Result
§15.207(a)	AC line conducted emissions	Compliant
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliant
§15.247 (a)(2)	6 dB Bandwidth	Compliant
§15.247(b)(3)	Maximum Conducted Output Power	Compliant
§15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliant
§15.247(e)	Power Spectral Density	Compliant
§15.203	Antenna Requirement	Compliant
FCC§15.247 (i) &§1.1307	RF Exposure Evaluation	Compliant

3. REQUIREMENTS AND TEST PROCEDURES

3.1 AC Line Conducted Emissions

3.1.1 Applicable Standard

FCC§15.207(a).

(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of emission (MHz)	Conducted limit (dB μ V)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

(b) The limit shown in paragraph (a) of this section shall not apply to carrier current systems operating as intentional radiators on frequencies below 30 MHz. In lieu thereof, these carrier current systems shall be subject to the following standards:

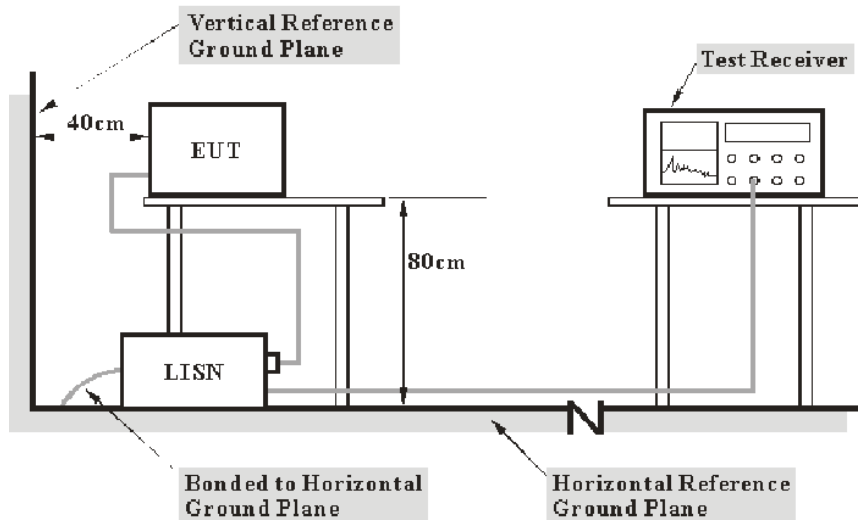
(1) For carrier current system containing their fundamental emission within the frequency band 535-1705 kHz and intended to be received using a standard AM broadcast receiver: no limit on conducted emissions.

(2) For all other carrier current systems: 1000 μ V within the frequency band 535-1705 kHz, as measured using a 50 μ H/50 ohms LISN.

(3) Carrier current systems operating below 30 MHz are also subject to the radiated emission limits in §15.205, §15.209, §15.221, §15.223, or §15.227, as appropriate.

(c) Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provisions for, the use of battery chargers which permit operating while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

3.1.2 EUT Setup



Note: 1. Support units were connected to second LISN.
 2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207, RSS-Gen limits.

The spacing between the peripherals was 10 cm.

3.1.3 EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

3.1.4 Test Procedure

The frequency and amplitude of the six highest ac power-line conducted emissions relative to the limit, measured over all the current-carrying conductors of the EUT power cords, and the operating frequency or frequency to which the EUT is tuned (if appropriate), should be reported, unless such emissions are more than 20 dB below the limit. AC power-line conducted emissions measurements are to be separately carried out only on each of the phase (“hot”) line(s) and (if used) on the neutral line(s), but not on the ground [protective earth] line(s). If less than six emission frequencies are within 20 dB of the limit, then the noise level of the measuring instrument at representative frequencies should be reported. The specific conductor of the power-line cord for each of the reported emissions should be identified. Measure the six highest emissions with respect to the limit on each current-carrying conductor of each power cord associated with the EUT (but not the power cords of associated or peripheral equipment that are part of the test configuration). Then, report the six highest emissions with respect to the limit from among all the measurements identifying the frequency and specific current-carrying conductor identified with the emission. The six highest emissions should be reported for each of the current-carrying conductors, or the six highest emissions may be reported over all the current-carrying conductors.

3.1.5 Corrected Result & Margin Calculation

The basic equation is as follows:

Result = Reading + Factor

Factor = attenuation caused by cable loss + voltage division factor of AMN

The “**Margin**” column of the following data tables indicates the degree of compliance within the applicable limit. The equation for margin calculation is as follows:

Margin = Limit – Result

3.2 Radiation Spurious Emissions

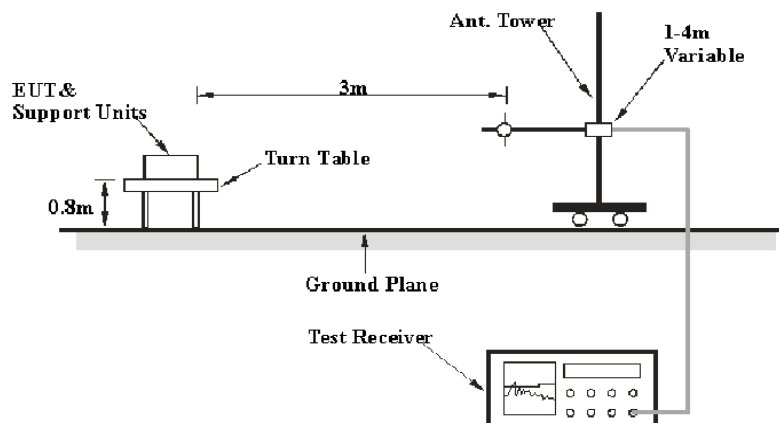
3.2.1 Applicable Standard

FCC §15.247 (d);

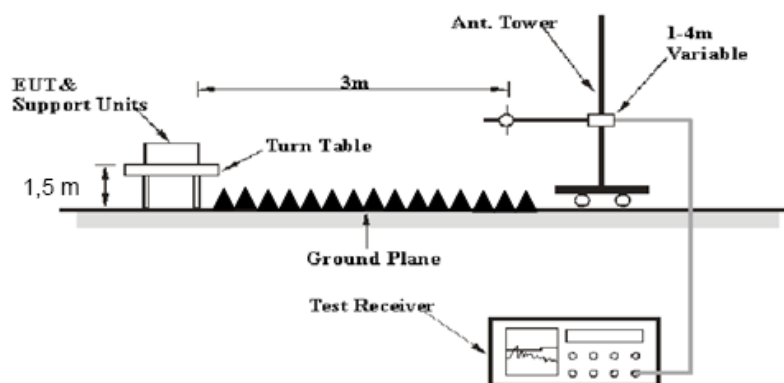
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

3.2.2 EUT Setup

Below 1GHz:



Above 1GHz:



The radiated emissions were performed in the 3 meters distance, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, FCC 15.247, RSS-247 and RSS-Gen limits.

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.

The spacing between the peripherals was 10 cm.

3.2.3 EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 25 GHz.

During the radiated emission test, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

30MHz-1000MHz:

Measurement	RBW	Video B/W	IF B/W
QP	120 kHz	300 kHz	120kHz

1GHz- 25GHz:

Measurement	Duty cycle	RBW	Video B/W
PK	Any	1MHz	3 MHz
AV	>98%	1MHz	10 Hz
	<98%	1MHz	1/T

If the maximized peak measured value complies with under the QP/Average limit more than 6dB, then it is unnecessary to perform an QP/Average measurement.

3.2.4 Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

Data was recorded in Quasi-peak detection mode for frequency range of 30 MHz-1 GHz, peak and Average detection modes for frequencies above 1 GHz.

3.2.5 Corrected Result & Margin Calculation

The basic equation is as follows:

Result = Reading + Factor

Factor = Antenna Factor + Cable Loss- Amplifier Gain

The “**Margin**” column of the following data tables indicates the degree of compliance within the applicable limit. The equation for margin calculation is as follows:

Margin = Limit – Result

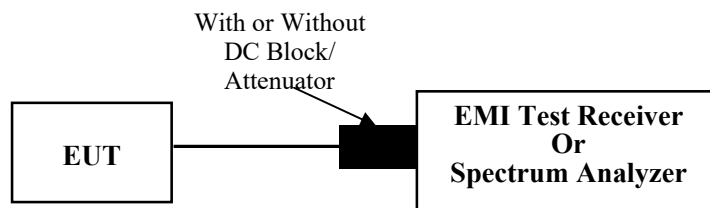
3.3 6 dB Emission Bandwidth:

3.3.1 Applicable Standard

FCC §15.247 (a)(2)

Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

3.3.2 EUT Setup



3.3.3 Test Procedure

According to ANSI C63.10-2013 Section 11.8

- a) Set RBW = 100 kHz.
- b) Set the video bandwidth (VBW) $\geq 3 \times \text{RBW}$.
- c) Detector = Peak.
- d) Trace mode = max hold.
- e) Sweep = auto couple.
- f) Allow the trace to stabilize.
- g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

3.4 Maximum conducted output power:

3.4.1 Applicable Standard

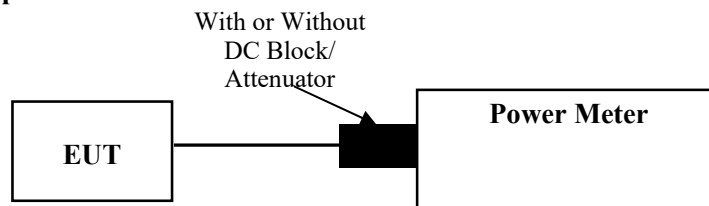
FCC §15.247 (b)(3)

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

RSS-247 Clause 5.4 d

For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

3.4.2 EUT Setup



3.4.3 Test Procedure

According to ANSI C63.10-2013 Section 11.9.1.3

The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall use a fast-responding diode detector.

- Set the EUT in transmitting mode.
- Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to test equipment.
- Add a correction factor to the display.
- Set the power meter to test peak output power, record the result.

3.5 Maximum power spectral density:

3.5.1 Applicable Standard

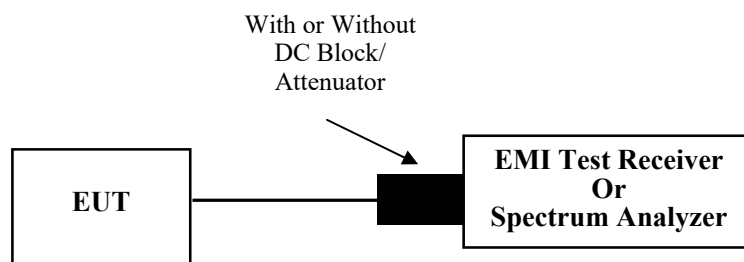
FCC §15.247 (e)

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

RSS-247 Clause 5.2 b

The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of section 5.4(d), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

3.5.2 EUT Setup



3.5.3 Test Procedure

According to ANSI C63.10-2013 Section 11.10.2

- a) Set analyzer center frequency to DTS channel center frequency.
- b) Set the span to 1.5 times the DTS bandwidth.
- c) Set the RBW to $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.
- d) Set the VBW $\geq [3 \cdot \text{RBW}]$.
- e) Detector = peak.
- f) Sweep time = auto couple.
- g) Trace mode = max hold.
- h) Allow trace to fully stabilize.
- i) Use the peak marker function to determine the maximum amplitude level within the RBW.
- j) If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat.

3.6 100 kHz Bandwidth of Frequency Band Edge:

3.6.1 Applicable Standard

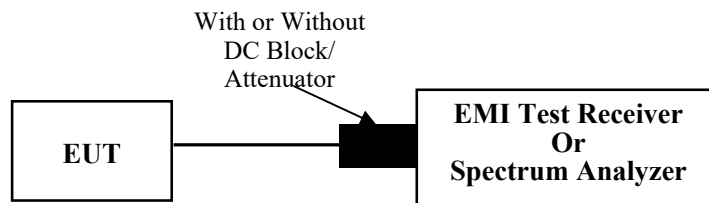
FCC §15.247 (d);

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

RSS-247 Clause 5.5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

3.6.2 EUT Setup



3.6.3 Test Procedure

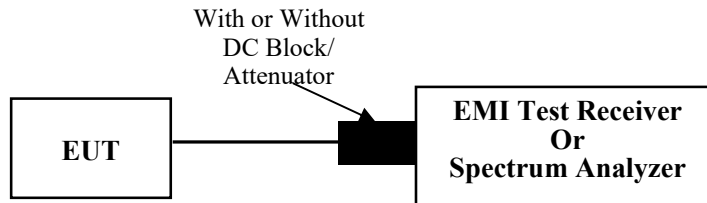
According to ANSI C63.10-2013 Section 11.11

- Set the center frequency and span to encompass frequency range to be measured.
- Set the RBW = 100 kHz.
- Set the VBW $\geq [3 \times \text{RBW}]$.
- Detector = peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum amplitude level.

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) is attenuated by at least the minimum requirements specified in 11.11. Report the three highest emissions relative to the limit.

3.7 Duty Cycle:

3.7.1 EUT Setup



3.7.2 Test Procedure

According to ANSI C63.10-2013 Section 11.6

The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the ON and OFF times of the transmitted signal:

- 1) Set the center frequency of the instrument to the center frequency of the transmission.
- 2) Set $RBW \geq OBW$ if possible; otherwise, set RBW to the largest available value.
- 3) Set $VBW \geq RBW$. Set detector = peak or average.
- 4) The zero-span measurement method shall not be used unless both RBW and VBW are $> 50/T$ and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring the duty cycle shall not be used if $T \leq 16.7 \mu s$.)

3.8 Antenna Requirement

3.8.1 Applicable Standard

FCC §15.203

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §§15.211, 15.213, 15.217, 15.219, 15.221, or §15.236. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

3.8.2 Judgment

Result: Compliant. Please refer to the Antenna Information detail in Section 1.

4. Test DATA AND RESULTS

4.1 AC Line Conducted Emissions

Serial Number:	1WKY-9	Test Date:	2022/12/30
Test Site:	CE	Test Mode:	Transmitting(BLE low channel was the worst)
Tester:	Vic Du	Test Result:	Pass

Environmental Conditions:

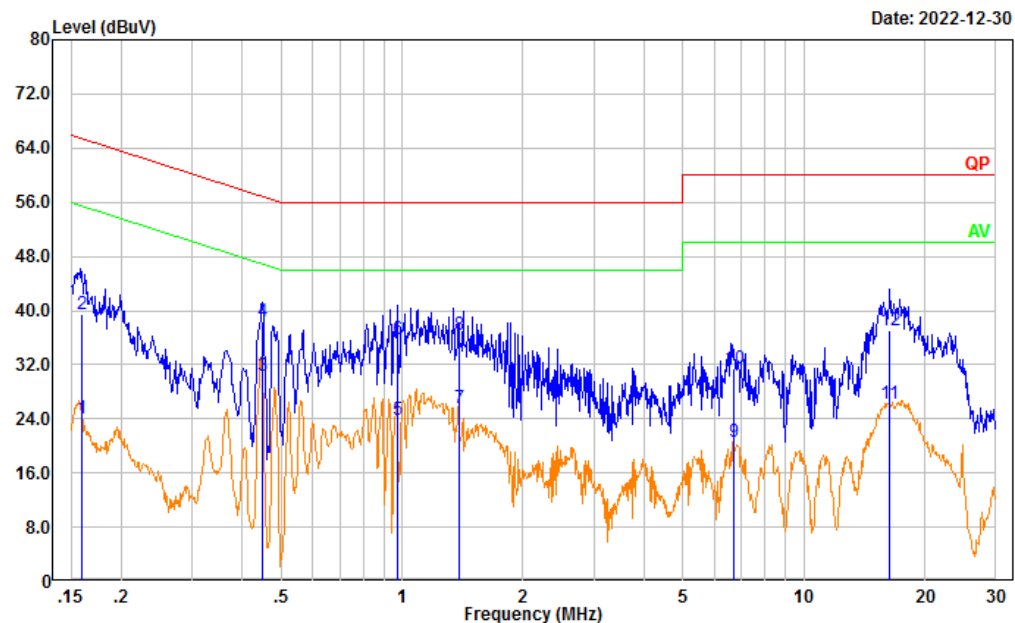
Temperature: (°C)	19.4	Relative Humidity: (%)	40	ATM Pressure: (kPa)	102.1
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Test Equipment List and Details:

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	LISN	ENV216	101134	2022/04/01	2023/03/31
R&S	EMI Test Receiver	ESR3	102726	2022/07/15	2023/07/14
MICRO-COAX	Coaxial Cable	UTIFLEX	C-0200-01	2022/08/07	2023/08/06
Audix	Test Software	E3	190306 (V9)	N/A	N/A

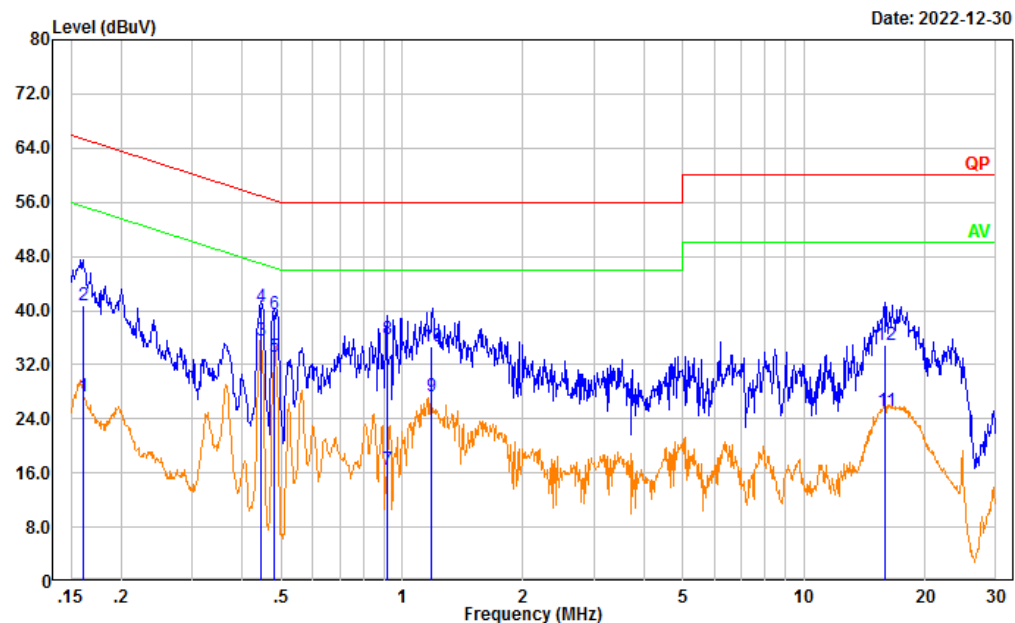
* Statement of Traceability: China Certification ICT Co., Ltd (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

Test Mode: Transmitting
Port: Line
Note:



No.	Frequency (MHz)	Reading (dBμV)	Factor (dB)	Result (dBμV)	Limit (dBμV)	Margin (dB)	Detector
1	0.160	14.39	9.61	24.00	55.49	31.49	Average
2	0.160	29.74	9.61	39.35	65.49	26.14	QP
3	0.449	20.76	9.61	30.37	46.89	16.52	Average
4	0.449	28.76	9.61	38.37	56.89	18.52	QP
5	0.976	14.12	9.62	23.74	46.00	22.26	Average
6	0.976	26.25	9.62	35.87	56.00	20.13	QP
7	1.383	15.90	9.62	25.52	46.00	20.48	Average
8	1.383	26.77	9.62	36.39	56.00	19.61	QP
9	6.668	10.91	9.66	20.57	50.00	29.43	Average
10	6.668	21.80	9.66	31.46	60.00	28.54	QP
11	16.316	16.44	9.72	26.16	50.00	23.84	Average
12	16.316	27.25	9.72	36.97	60.00	23.03	QP

Test Mode: Transmitting
Port: neutral
Note:



No.	Frequency (MHz)	Reading (dBμV)	Factor (dB)	Result (dBμV)	Limit (dBμV)	Margin (dB)	Detector
<hr/>							
1	0.161	17.78	9.61	27.39	55.43	28.04	Average
2	0.161	31.25	9.61	40.86	65.43	24.57	QP
3	0.446	25.98	9.61	35.59	46.94	11.35	Average
4	0.446	30.86	9.61	40.47	56.94	16.47	QP
5	0.480	23.55	9.61	33.16	46.34	13.18	Average
6	0.480	29.81	9.61	39.42	56.34	16.92	QP
7	0.916	6.88	9.62	16.50	46.00	29.50	Average
8	0.916	26.26	9.62	35.88	56.00	20.12	QP
9	1.179	17.77	9.62	27.39	46.00	18.61	Average
10	1.179	25.16	9.62	34.78	56.00	21.22	QP
11	15.967	15.52	9.69	25.21	50.00	24.79	Average
12	15.967	25.11	9.69	34.80	60.00	25.20	QP

4.2 Radiation Spurious Emissions

Serial Number:	1WKY-9,1WKZ-10	Test Date:	2023/1/10~2023/3/2
Test Site:	966-1,966-2	Test Mode:	Transmitting
Tester:	Mack Huang,Carl Xue	Test Result:	Pass

Environmental Conditions:

Temperature: (°C)	20.5~24.4	Relative Humidity: (%)	50~51	ATM Pressure: (kPa)	100.9~102.4
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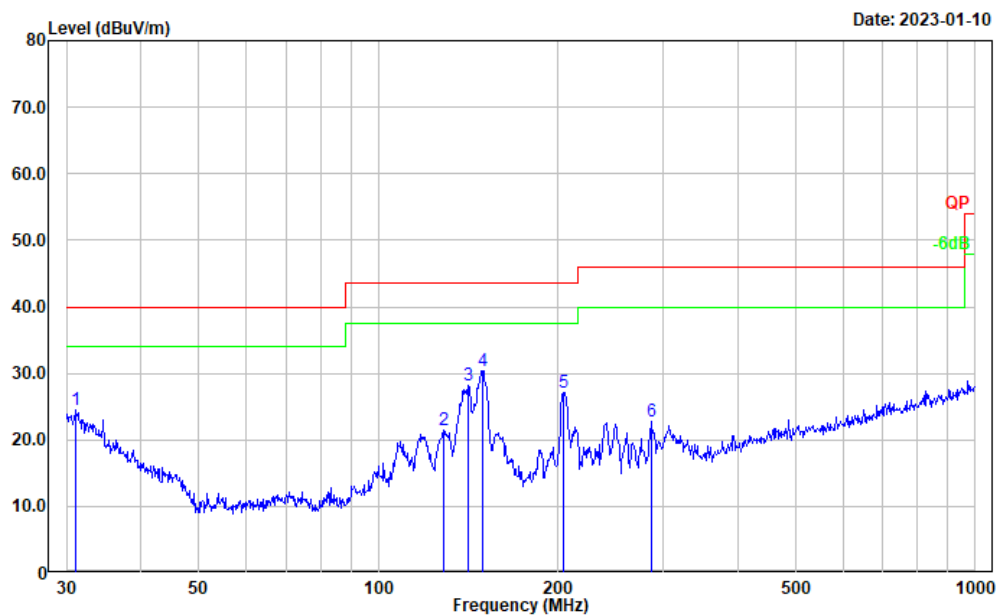
Test Equipment List and Details:

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Sunol Sciences	Antenna	JB6	A082520-5	2020/10/19	2023/10/18
R&S	EMI Test Receiver	ESR3	102724	2022/07/15	2023/07/14
TIMES MICROWAVE	Coaxial Cable	LMR-600-UltraFlex	C-0470-02	2022/07/17	2023/07/16
TIMES MICROWAVE	Coaxial Cable	LMR-600-UltraFlex	C-0780-01	2022/07/17	2023/07/16
Sonoma	Amplifier	310N	186165	2022/07/17	2023/07/16
Audix	Test Software	E3	201021 (V9)	N/A	N/A
ETS-Lindgren	Horn Antenna	3115	9912-5985	2020/10/13	2023/10/12
R&S	Spectrum Analyzer	FSV40	101591	2022/07/15	2023/07/14
MICRO-COAX	Coaxial Cable	UFA210A-1-1200-70U300	217423-008	2022/08/07	2023/08/06
MICRO-COAX	Coaxial Cable	UFA210A-1-2362-300300	235780-001	2022/08/07	2023/08/06
Mini	Pre-amplifier	ZVA-183-S+	5969001149	2022/11/09	2023/11/08
PASTERNAK	Horn Antenna	PE9852/2F-20	112002	2021/02/05	2024/02/04
AH	Preamplifier	PAM-1840VH	190	2022/11/09	2023/11/08
MICRO-COAX	Coaxial Cable	UFB142A-1-2362-200200	235772-001	2022/08/07	2023/08/06
E-Microwave	Band Rejection Filter	2400-2483.5MHz	OE01902424	2022/08/07	2023/08/06
Mini Circuits	High Pass Filter	VHF-6010+	31119	2022/08/07	2023/08/06

* Statement of Traceability: China Certification ICT Co., Ltd (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

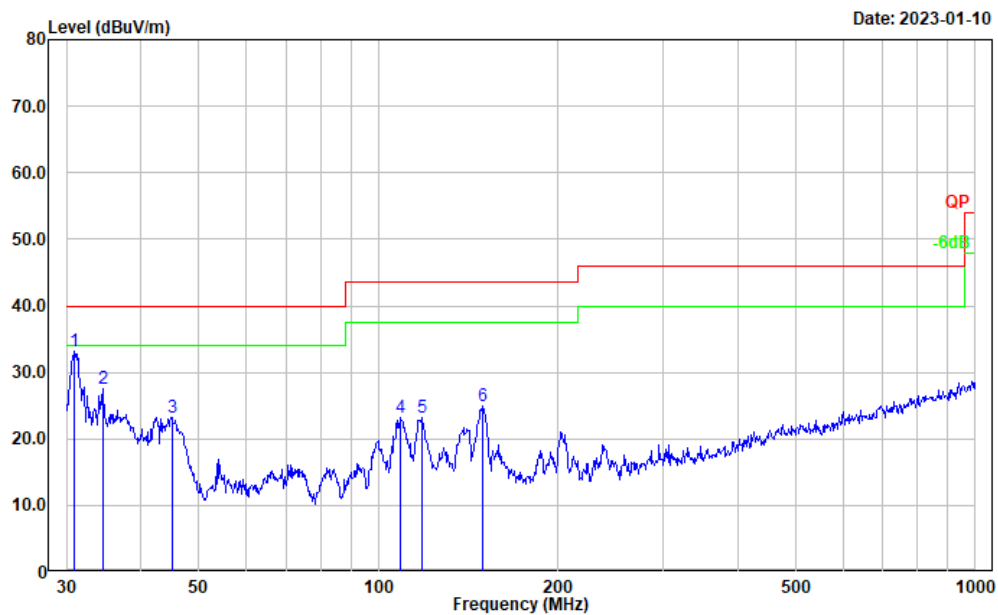
1) 30MHz-1GHz (BLE low channel was the worst)**Adapter:**

Test Mode: Transmitting
Polarization: horizontal
Note:



No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
1	31.071	28.99	-4.43	24.56	40.00	15.44	Peak
2	128.563	32.70	-11.28	21.42	43.50	22.08	Peak
3	141.330	40.06	-11.93	28.13	43.50	15.37	Peak
4	149.486	42.45	-12.00	30.45	43.50	13.05	Peak
5	204.238	39.53	-12.33	27.20	43.50	16.30	Peak
6	285.978	33.96	-11.28	22.68	46.00	23.32	Peak

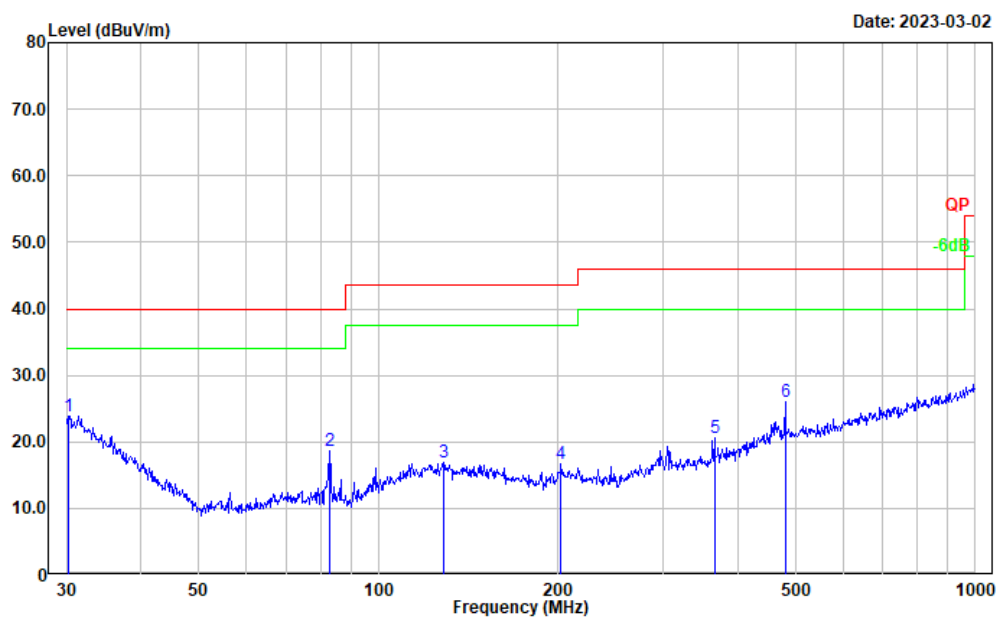
Test Mode: Transmitting
Polarization: vertical
Note:



No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
1	30.853	37.37	-4.26	33.11	40.00	6.89	Peak
2	34.517	34.55	-7.09	27.46	40.00	12.54	Peak
3	45.058	37.44	-14.25	23.19	40.00	16.81	Peak
4	108.647	35.70	-12.54	23.16	43.50	20.34	Peak
5	118.186	34.77	-11.63	23.14	43.50	20.36	Peak
6	149.486	36.94	-12.00	24.94	43.50	18.56	Peak

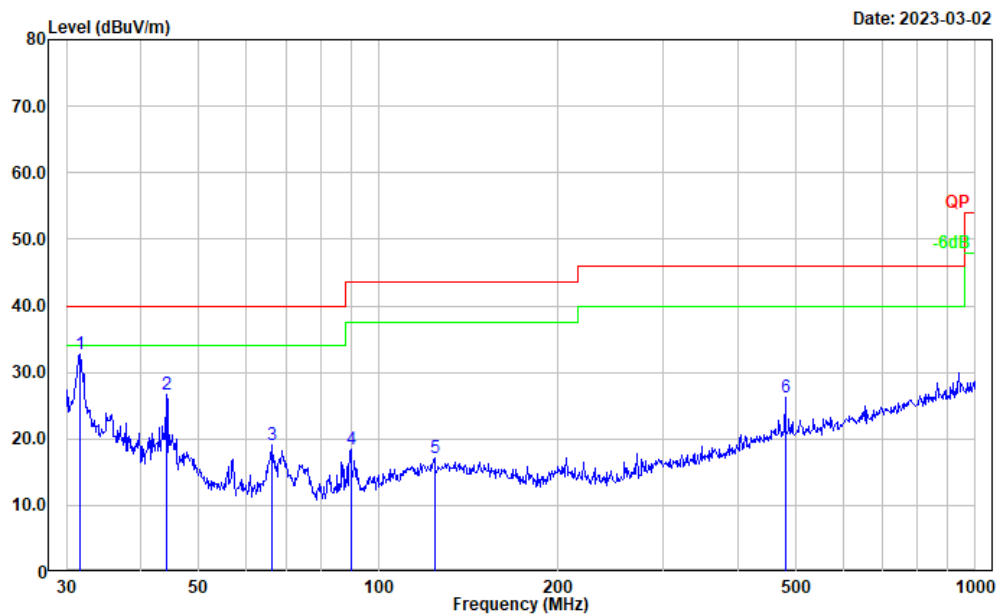
Solar panel:

Test Mode: Transmitting
Polarization: horizontal
Note:



No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
1	30.211	27.70	-3.76	23.94	40.00	16.06	Peak
2	82.648	35.82	-17.28	18.54	40.00	21.46	Peak
3	128.563	28.18	-11.28	16.90	43.50	26.60	Peak
4	202.100	29.04	-12.28	16.76	43.50	26.74	Peak
5	365.539	30.26	-9.64	20.62	46.00	25.38	Peak
6	480.528	32.36	-6.25	26.11	46.00	19.89	Peak

Test Mode: Transmitting
Polarization: vertical
Note:



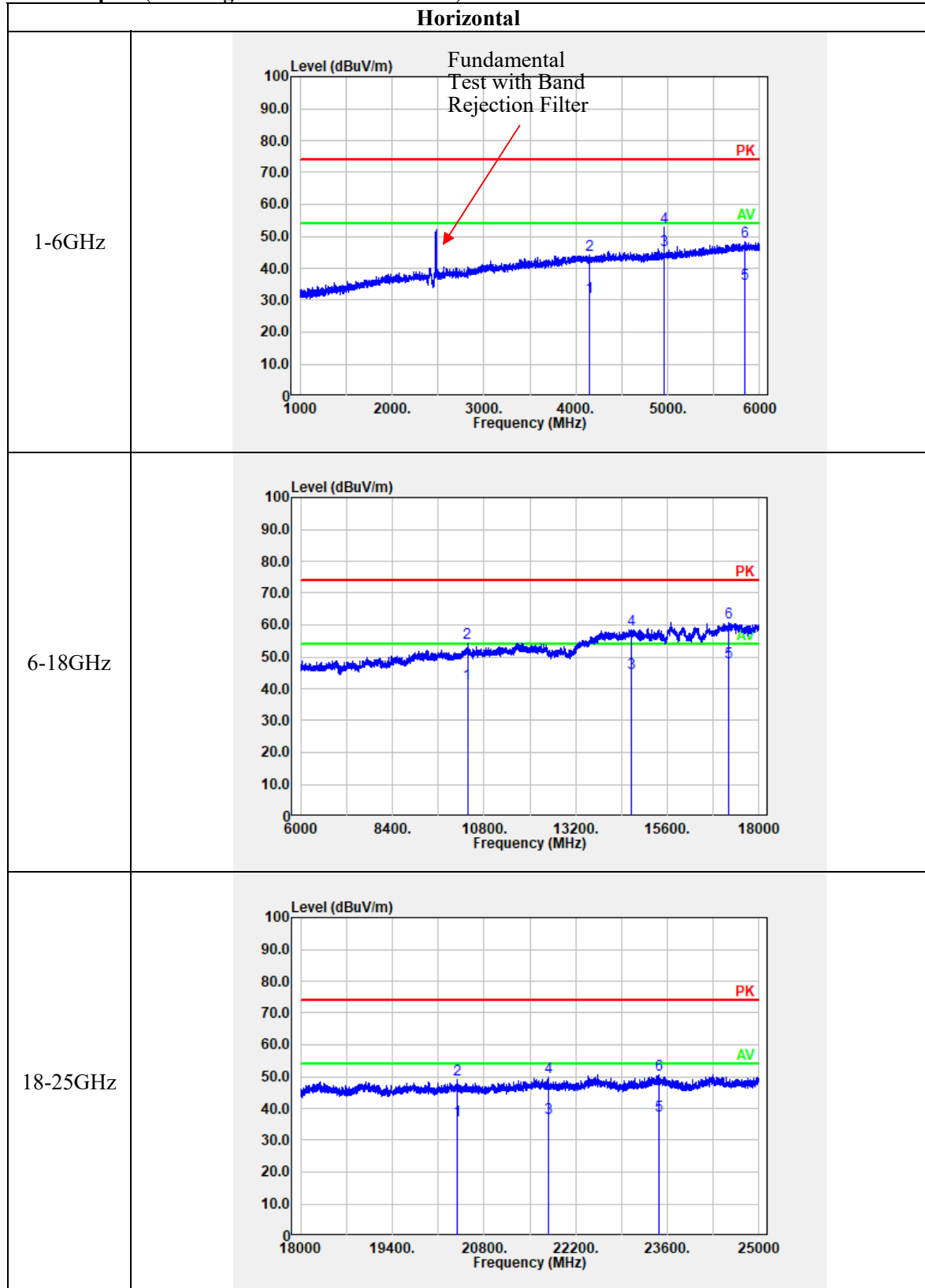
No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
1	31.620	37.49	-4.83	32.66	40.00	7.34	Peak
2	44.120	40.37	-13.73	26.64	40.00	13.36	Peak
3	66.266	35.97	-16.84	19.13	40.00	20.87	Peak
4	89.905	35.38	-16.93	18.45	43.50	25.05	Peak
5	124.133	28.43	-11.38	17.05	43.50	26.45	Peak
6	480.528	32.51	-6.25	26.26	46.00	19.74	Peak

**2) Above 1GHz(Adapter was the worst):
BLE 1Mbps:**

Frequency (MHz)	Receiver		Polar (H/V)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	Detector					
Low Channel: 2402 MHz							
2402.000	68.35	PK	H	31.51	99.86	N/A	N/A
2402.000	64.06	AV	H	31.51	95.57	N/A	N/A
2402.000	61.35	PK	V	31.51	92.86	N/A	N/A
2402.000	56.99	AV	V	31.51	88.50	N/A	N/A
2390.000	27.81	PK	H	31.46	59.27	74.00	14.73
2390.000	13.90	AV	H	31.46	45.36	54.00	8.64
4804.000	41.38	PK	H	10.91	52.29	74.00	21.71
4804.000	34.49	AV	H	10.91	45.40	54.00	8.60
7206.000	38.23	PK	H	14.22	52.45	74.00	21.55
7206.000	25.13	AV	H	14.22	39.35	54.00	14.65
Middle Channel: 2440 MHz							
2440.000	67.64	PK	H	31.60	99.24	N/A	N/A
2440.000	63.42	AV	H	31.60	95.02	N/A	N/A
2440.000	60.06	PK	V	31.60	91.66	N/A	N/A
2440.000	56.13	AV	V	31.60	87.73	N/A	N/A
4880.000	41.53	PK	H	11.07	52.60	74.00	21.40
4880.000	34.21	AV	H	11.07	45.28	54.00	8.72
7320.000	37.56	PK	H	14.80	52.36	74.00	21.64
7320.000	24.35	AV	H	14.80	39.15	54.00	14.85
High Channel: 2480 MHz							
2480.000	67.80	PK	H	31.64	99.44	N/A	N/A
2480.000	63.73	AV	H	31.64	95.37	N/A	N/A
2480.000	60.34	PK	V	31.64	91.98	N/A	N/A
2480.000	56.73	AV	V	31.64	88.37	N/A	N/A
2483.500	38.53	PK	H	31.64	70.17	74.00	3.83
2483.500	14.60	AV	H	31.64	46.24	54.00	7.76
4960.000	42.10	PK	H	11.23	53.33	74.00	20.67
4960.000	35.05	AV	H	11.23	46.28	54.00	7.72
7440.000	36.57	PK	H	15.26	51.83	74.00	22.17
7440.000	23.46	AV	H	15.26	38.72	54.00	15.28

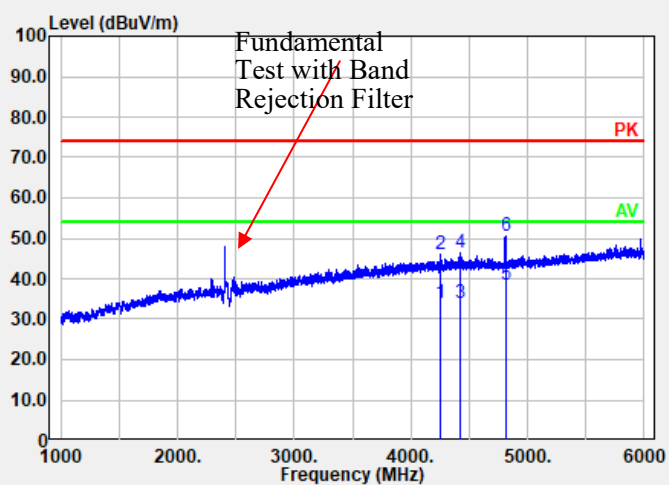
Zigbee:

Frequency (MHz)	Receiver		Polar (H/V)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	Detector					
Low Channel: 2405 MHz							
2405.000	61.57	PK	H	31.51	93.08	N/A	N/A
2405.000	59.30	AV	H	31.51	90.81	N/A	N/A
2405.000	60.62	PK	V	31.51	92.13	N/A	N/A
2405.000	58.43	AV	V	31.51	89.94	N/A	N/A
2390.000	26.81	PK	H	31.46	58.27	74.00	15.73
2390.000	13.86	AV	H	31.46	45.32	54.00	8.68
4810.000	39.06	PK	H	10.92	49.98	74.00	24.02
4810.000	27.03	AV	H	10.92	37.95	54.00	16.05
7215.000	34.60	PK	H	14.28	48.88	74.00	25.12
7215.000	22.30	AV	H	14.28	36.58	54.00	17.42
Middle Channel: 2440 MHz							
2440.000	61.21	PK	H	31.60	92.81	N/A	N/A
2440.000	59.17	AV	H	31.60	90.77	N/A	N/A
2440.000	58.84	PK	V	31.60	90.44	N/A	N/A
2440.000	56.31	AV	V	31.60	87.91	N/A	N/A
4880.000	37.85	PK	H	11.07	48.92	74.00	25.08
4880.000	25.43	AV	H	11.07	36.50	54.00	17.50
7320.000	34.80	PK	H	14.80	49.60	74.00	24.40
7320.000	22.40	AV	H	14.80	37.20	54.00	16.80
High Channel: 2480 MHz							
2480.000	59.80	PK	H	31.64	91.44	N/A	N/A
2480.000	57.37	AV	H	31.64	89.01	N/A	N/A
2480.000	58.39	PK	V	31.64	90.03	N/A	N/A
2480.000	56.12	AV	V	31.64	87.76	N/A	N/A
2483.500	27.58	PK	H	31.64	59.22	74.00	14.78
2483.500	14.48	AV	H	31.64	46.12	54.00	7.88
4960.000	37.66	PK	H	11.23	48.89	74.00	25.11
4960.000	25.33	AV	H	11.23	36.56	54.00	17.44
7440.000	33.21	PK	H	15.26	48.47	74.00	25.53
7440.000	21.11	AV	H	15.26	36.37	54.00	17.63

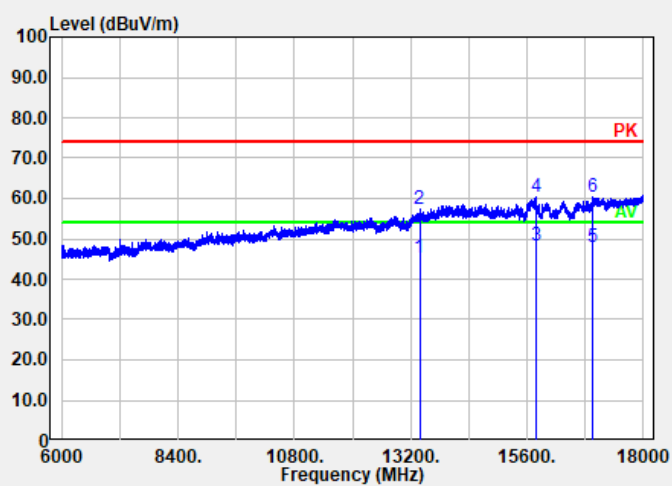
Worst Test plots(BLE High channel was the worst)

Vertical

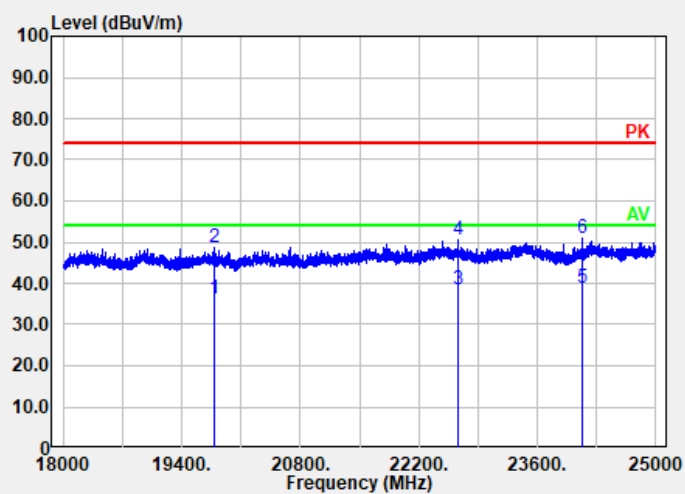
1-6GHz



6-18GHz



18-25GHz



4.3 6 dB Emission Bandwidth:

Serial Number:	1WKY-9	Test Date:	2023/1/10~2023/1/11
Test Site:	RF	Test Mode:	Transmitting
Tester:	Claire Liu	Test Result:	Pass

Environmental Conditions:

Temperature: (°C)	24.5~24.8	Relative Humidity: (%)	54~57	ATM Pressure: (kPa)	101.2~101.3
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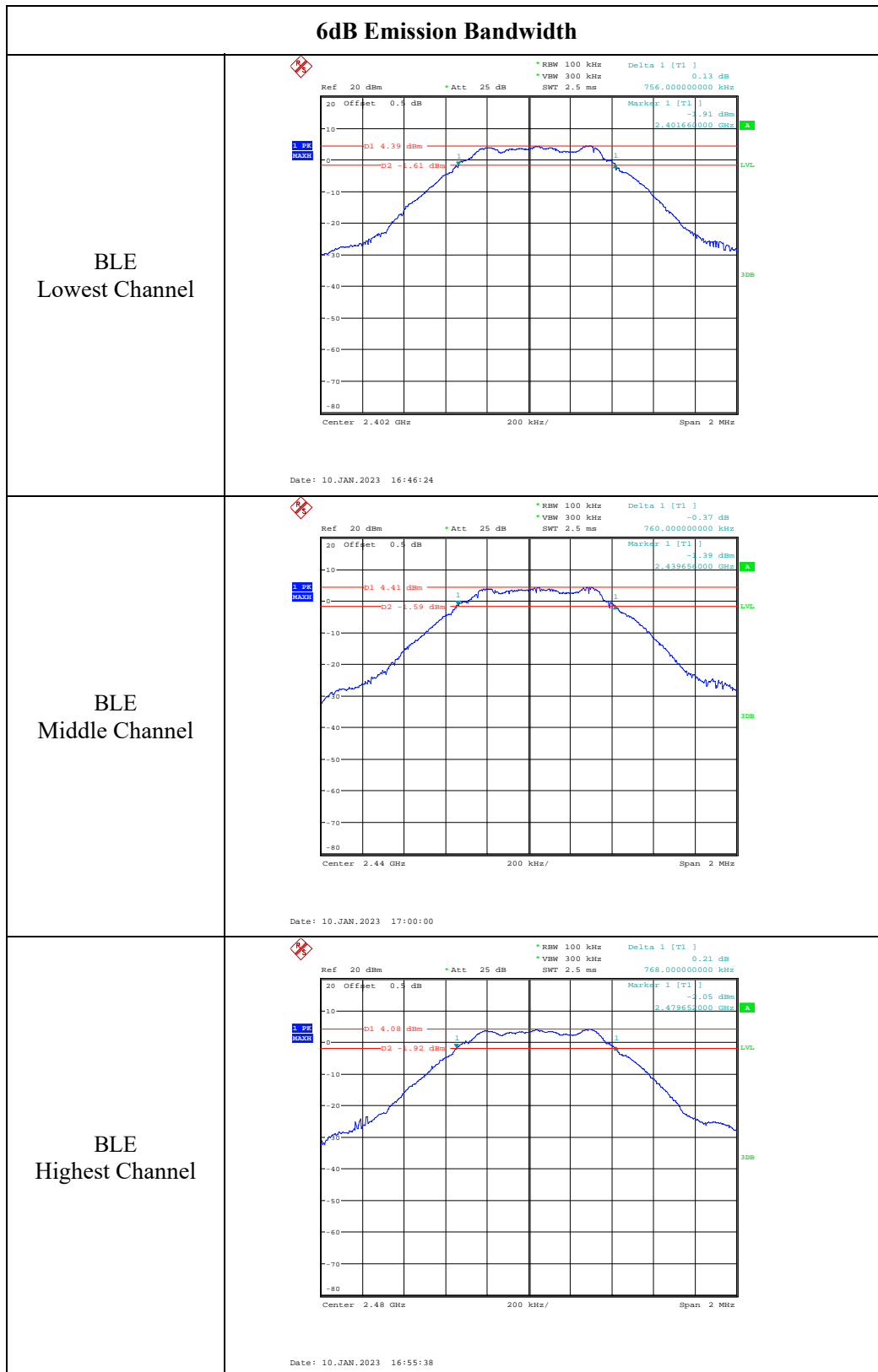
Test Equipment List and Details:

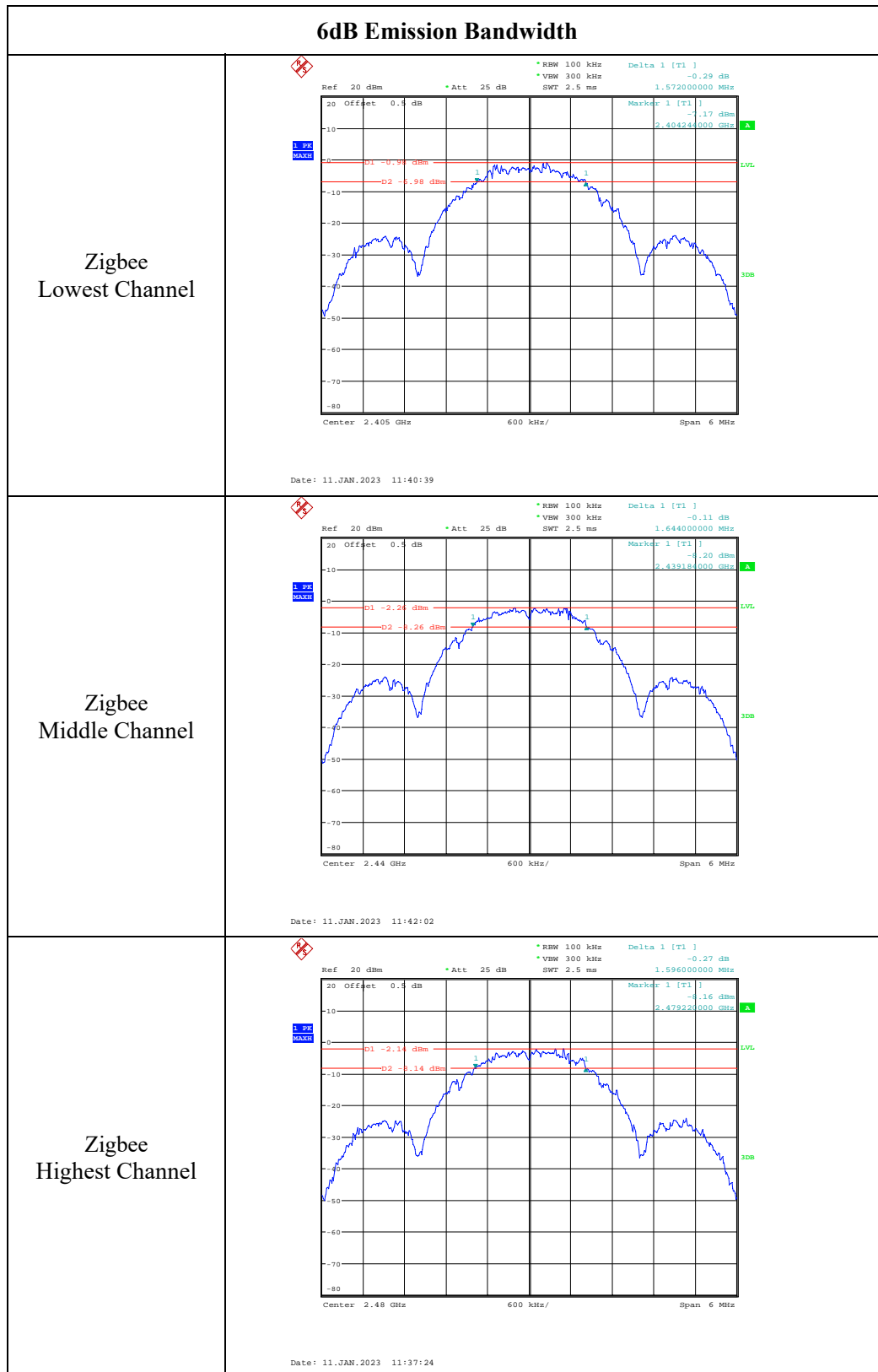
Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSU26	200256	2022/07/15	2023/07/14
zhuoxiang	Coaxial Cable	SMA-178	211001	Each time	N/A

* Statement of Traceability: China Certification ICT Co., Ltd (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

Test Data:

Test Modes	Test Frequency (MHz)	6 dB Bandwidth (MHz)	Limit (MHz)
BLE 1Mbps	2402	0.756	≥ 0.5
	2440	0.760	≥ 0.5
	2480	0.768	≥ 0.5
ZigBee	2405	1.572	≥ 0.5
	2440	1.644	≥ 0.5
	2480	1.596	≥ 0.5





4.4 99% Occupied Bandwidth:

Serial Number:	1WKY-9	Test Date:	2023/1/10~2023/1/11
Test Site:	RF	Test Mode:	Transmitting
Tester:	Claire Liu	Test Result:	N/A

Environmental Conditions:

Temperature: (°C)	24.5~24.8	Relative Humidity: (%)	54~57	ATM Pressure: (kPa)	101.2~101.3
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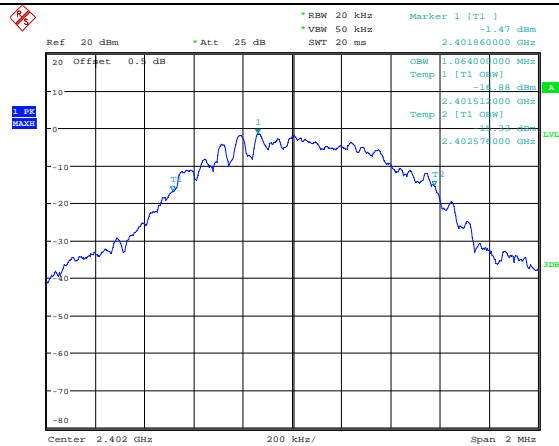
Test Equipment List and Details:

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSU26	200256	2022/07/15	2023/07/14
zhuoxiang	Coaxial Cable	SMA-178	211001	Each time	N/A

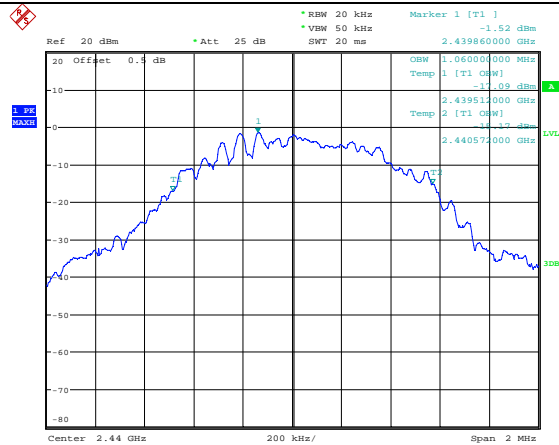
** Statement of Traceability: China Certification ICT Co., Ltd (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).*

Test Data:

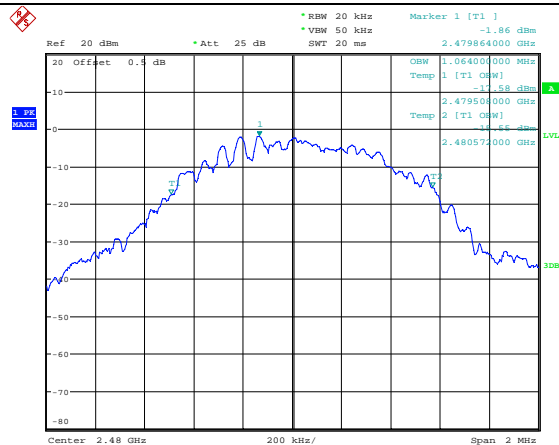
Test Modes	Test Frequency (MHz)	99% Occupied Bandwidth (MHz)
BLE 1Mbps	2402	1.064
	2440	1.060
	2480	1.064
Zigbee	2405	2.580
	2440	2.592
	2480	2.568

99% Occupied BandwidthBLE 1Mbps
Lowest Channel

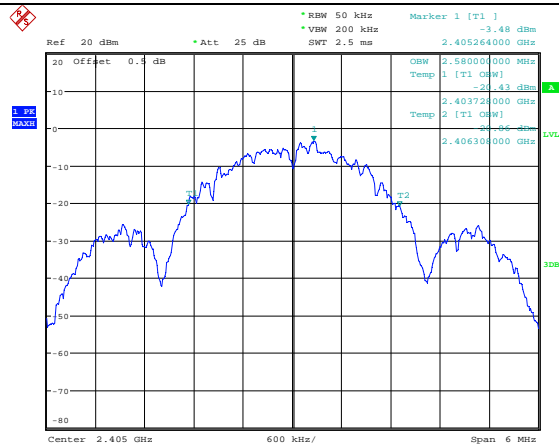
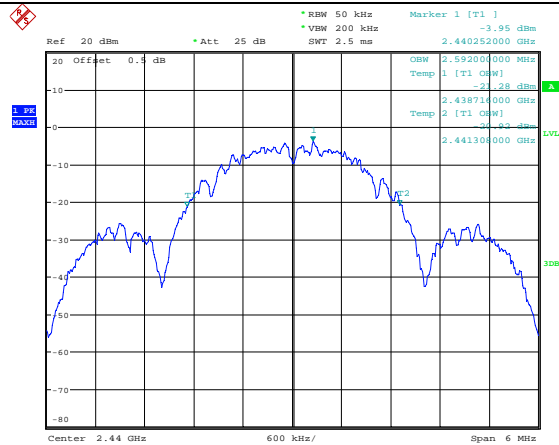
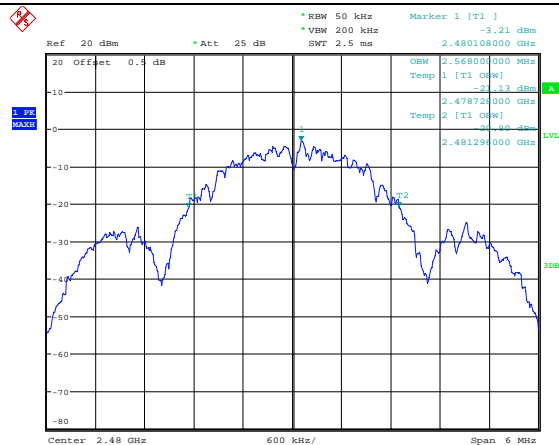
Date: 10.JAN.2023 16:46:38

BLE 1Mbps
Middle Channel

Date: 10.JAN.2023 17:00:13

BLE 1Mbps
Highest Channel

Date: 10.JAN.2023 16:55:46

99% Occupied BandwidthZigbee
Lowest ChannelZigbee
Middle ChannelZigbee
Highest Channel

4.5 Maximum conducted output power:

Serial Number:	1WKY-9	Test Date:	2023/1/10~2023/1/11
Test Site:	RF	Test Mode:	Transmitting
Tester:	Claire Liu	Test Result:	Pass

Environmental Conditions:

Temperature: (°C)	24.5~24.8	Relative Humidity: (%)	54~57	ATM Pressure: (kPa)	101.2~101.3
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Test Equipment List and Details:

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
zhuoxiang	Coaxial Cable	SMA-178	211001	Each time	N/A
Agilent	USB Wideband Power Sensor	U2021XA	MY54080015	2022/07/15	2023/07/14

* Statement of Traceability: China Certification ICT Co., Ltd (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

Test Data:

Test Modes	Test Channel	Test Frequency (MHz)	Maximum Conducted Peak Output Power (dBm)	Limit (dBm)
BLE 1Mbps	Lowest	2402	6.17	≤30
	Middle	2440	6.17	≤30
	Highest	2480	5.85	≤30
Zigbee	Lowest	2405	4.12	≤30
	Middle	2440	3.96	≤30
	Highest	2480	3.74	≤30

4.6 Maximum power spectral density:

Serial Number:	1WKY-9	Test Date:	2023/1/10~2023/1/11
Test Site:	RF	Test Mode:	Transmitting
Tester:	Claire Liu	Test Result:	Pass

Environmental Conditions:

Temperature: (°C)	24.5~24.8	Relative Humidity: (%)	54~57	ATM Pressure: (kPa)	101.2~101.3
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Test Equipment List and Details:

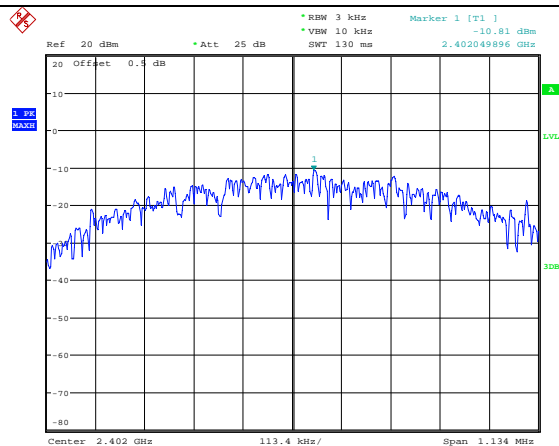
Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSU26	200256	2022/07/15	2023/07/14
zhuoxiang	Coaxial Cable	SMA-178	211001	Each time	N/A

** Statement of Traceability: China Certification ICT Co., Ltd (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).*

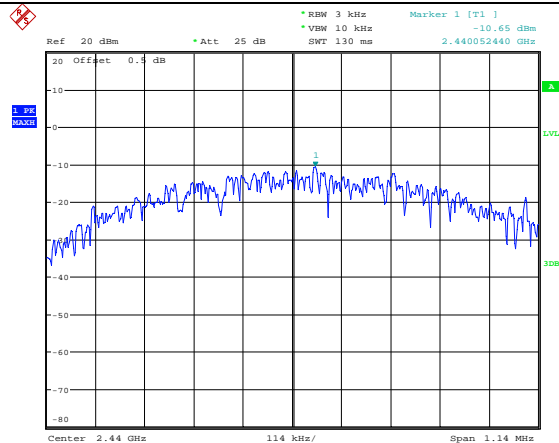
Test Data:

Test Channel	Test Frequency (MHz)	Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)
BLE 1Mbps	2402	-10.81	≤8.00
	2440	-10.65	≤8.00
	2480	-10.93	≤8.00
Zigbee	2405	-11.76	≤8.00
	2440	-12.05	≤8.00
	2480	-12.24	≤8.00

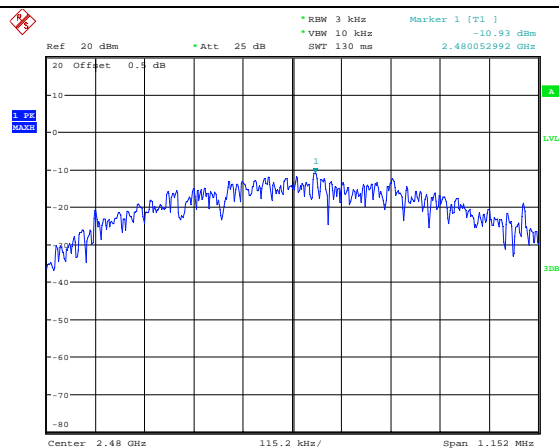
Maximum power spectral density

BLE 1Mbps
Lowest Channel

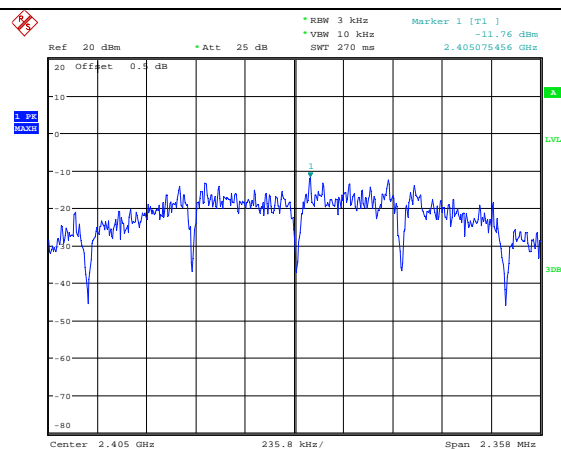
Date: 10.JAN.2023 16:47:01

BLE 1Mbps
Middle Channel

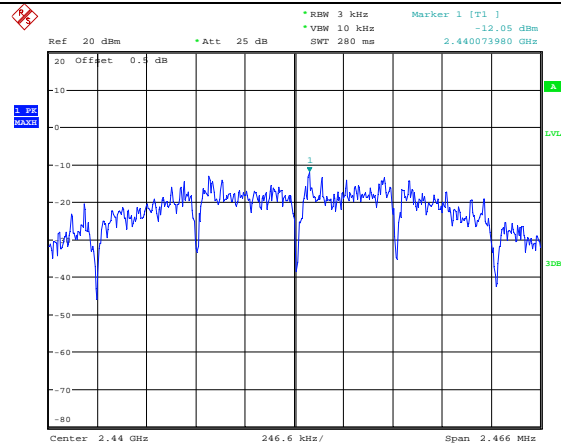
Date: 10.JAN.2023 17:00:37

BLE 1Mbps
Highest Channel

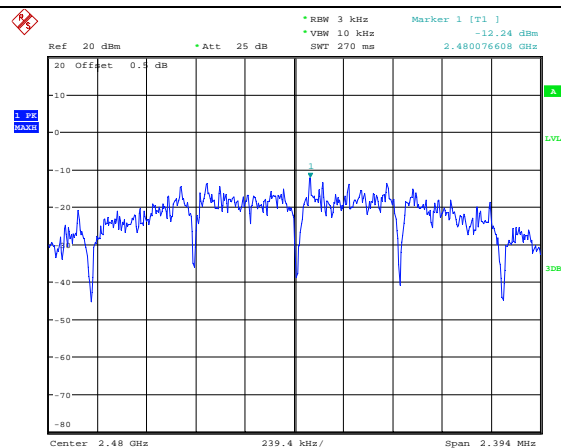
Date: 10.JAN.2023 16:56:07

Maximum power spectral densityZigbee
Lowest Channel

Date: 11.JAN.2023 11:41:11

Zigbee
Middle Channel

Date: 11.JAN.2023 11:42:54

Zigbee
Highest Channel

Date: 11.JAN.2023 11:37:54

4.7 100 kHz Bandwidth of Frequency Band Edge:

Serial Number:	1WKY-9	Test Date:	2023/1/10~2023/1/11
Test Site:	RF	Test Mode:	Transmitting
Tester:	Claire Liu	Test Result:	Pass

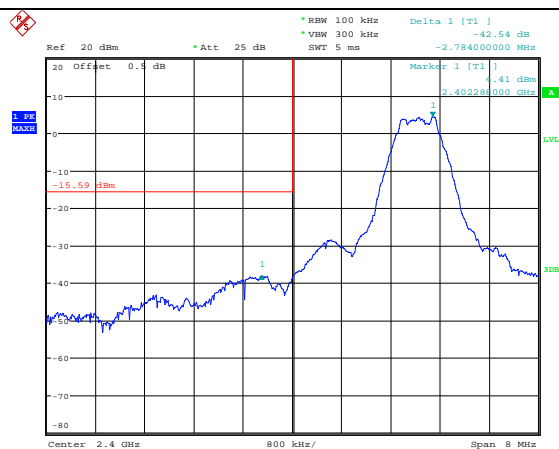
Environmental Conditions:

Temperature: (°C)	24.5~24.8	Relative Humidity: (%)	54~57	ATM Pressure: (kPa)	101.2~101.3
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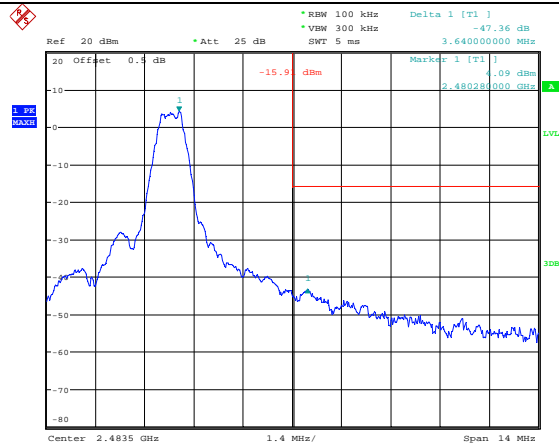
Test Equipment List and Details:

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSU26	200256	2022/07/15	2023/07/14
zhuoxiang	Coaxial Cable	SMA-178	211001	Each time	N/A

** Statement of Traceability: China Certification ICT Co., Ltd (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).*

100 kHz Bandwidth of Frequency Band EdgeBLE 1Mbps
Lowest Band edge

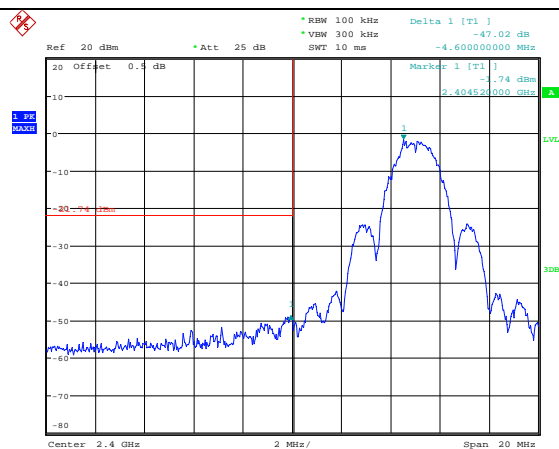
Date: 10.JAN.2023 16:47:18

BLE 1Mbps
Highest Band edge

Date: 10.JAN.2023 16:56:17

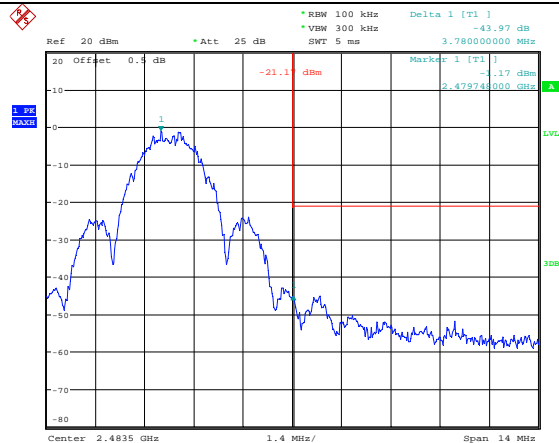
100 kHz Bandwidth of Frequency Band Edge

Zigbee
Lowest Band edge



Date: 11.JAN.2023 11:40:10

Zigbee
Highest Band edge



Date: 11.JAN.2023 11:37:03

4.8 Duty Cycle:

Serial Number:	1WKY-9	Test Date:	2023/1/10~2023/1/11
Test Site:	RF	Test Mode:	Transmitting
Tester:	Claire Liu	Test Result:	N/A

Environmental Conditions:

Temperature: (°C)	24.5~24.8	Relative Humidity: (%)	54~57	ATM Pressure: (kPa)	101.2~101.3
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Test Equipment List and Details:

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSU26	200256	2022/07/15	2023/07/14
zhuoxiang	Coaxial Cable	SMA-178	211001	Each time	N/A

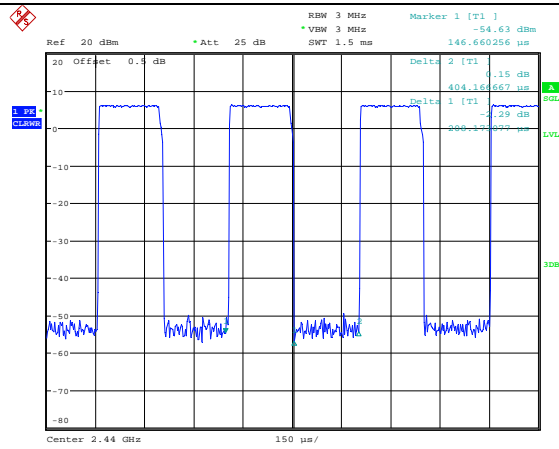
** Statement of Traceability: China Certification ICT Co., Ltd (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).*

Test Data:

Test Modes	Ton (ms)	Ton+off (ms)	Duty cycle (%)	1/T (kHz)
BLE 1Mbps	0.208	0.404	51.49	4.808
Zigbee	1.273	2.381	53.46	0.786

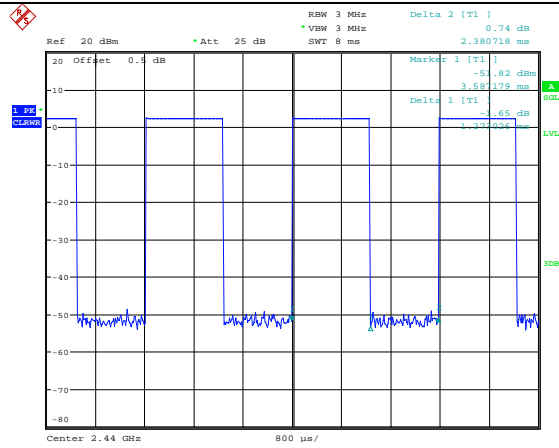
Duty Cycle

BLE 1Mbps



Date: 10.JAN.2023 17:14:18

Zigbee



Date: 11.JAN.2023 11:45:17

5. RF EXPOSURE EVALUATION

5.1 Applicable Standard

FCC §15.247 (i)

Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See §1.1307(b)(1) of this chapter.

5.2 Procedure

According to §1.1307(b)(3)(ii)(B)

Simultaneous Transmission with both SAR-based and MPE-Based Test Exemptions

This case is described in detail in § 1.1307(b)(3)(ii)(B) and covers the situations where both SAR-based and MPE-based exemption may be considered for test exemption in fixed, mobile, or portable device exposure conditions. For these cases, a device with multiple RF sources transmitting simultaneously will be considered an RF exempt device if the condition of Formula (1) is satisfied.

Table 1 to § 1.1307(b)(3)(i)(C) - Single RF Sources Subject to Routine Environmental Evaluation

RF Source frequency (MHz)	Threshold ERP (watts)
0.3-1.34	$1,920 R^2$.
1.34-30	$3,450 R^2/f^2$.
30-300	$3.83 R^2$.
300-1,500	$0.0128 R^2 f$.
1,500-100,000	$19.2 R^2$.

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure\ Limit_k} \leq 1 \quad (1)$$

Where:

a = number of fixed, mobile, or portable RF sources claiming exemption using [paragraph \(b\)\(3\)\(i\)\(B\)](#) of this section for P_{th} , including existing exempt transmitters and those being added.

b = number of fixed, mobile, or portable RF sources claiming exemption using [paragraph \(b\)\(3\)\(i\)\(C\)](#) of this section for Threshold ERP, including existing exempt transmitters and those being added.

c = number of existing fixed, mobile, or portable RF sources with known evaluation for the specified minimum distance including existing evaluated transmitters.

P_i = the available maximum time-averaged power or the ERP, whichever is greater, for fixed, mobile, or portable RF source i at a distance between 0.5 cm and 40 cm (inclusive).

$P_{th,i}$ = the exemption threshold power (P_{th}) according to [paragraph \(b\)\(3\)\(i\)\(B\)](#) of this section for fixed, mobile, or portable RF source i .

ERP_j = the ERP of fixed, mobile, or portable RF source j .

$ERP_{th,j}$ = exemption threshold ERP for fixed, mobile, or portable RF source j , at a distance of at least $\lambda/2\pi$ according to the applicable formula of [paragraph \(b\)\(3\)\(i\)\(C\)](#) of this section.

$Evaluated_k$ = the maximum reported SAR or MPE of fixed, mobile, or portable RF source k either in the device or at the transmitter site from an existing evaluation at the location of exposure.

$Exposure\ Limit_k$ = either the general population/uncontrolled maximum permissible exposure (MPE) or specific absorption rate (SAR) limit for each fixed, mobile, or portable RF source k , as applicable from [§ 1.1310 of this chapter](#).

5.3 Measurement Result

Radio	Frequency (MHz)	$\lambda / 2$ Π (mm)	Distance (mm)	Exemption ERP (mW)	Maximum Conducted Power including Tune-up Tolerance (dBm)	Antenna Gain (dBi)	ERP	
							dBm	mW
BLE	2402-2480	19.88	200	768	7	-0.80	4.05	2.54
Zigbee	2405-2480	19.85	200	768	5	-1.04	1.81	1.52

Note:

The BLE and Zigbee can transmit simultaneously.

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure Limit_k}$$

$$= ERP_{BLE} / ERP_{th} + ERP_{Zigbee} / ERP_{th}$$

$$= 2.54/768 + 1.52/768$$

$$= 0.005$$

$$< 1.0$$

Result: The device compliant the MPE-Based Exemption at 20cm distances.

===== END OF REPORT =====